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Filed: Herewith Docket No.: MSFT-3008/304862.03 App. No.: Not Yet Assigned Title: SYSTEMS AND METHODS FOR ENHANCING PERFORMANCE OF A COPROCESSOR

Inventors: Anuj B. Gosalia and Steve Pronovost

Attorney: Nathaniel Ari Long Phone: (215) 568-3100

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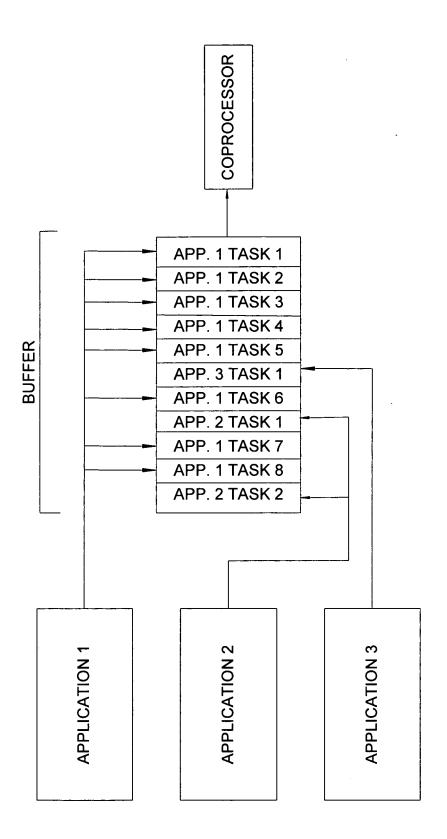
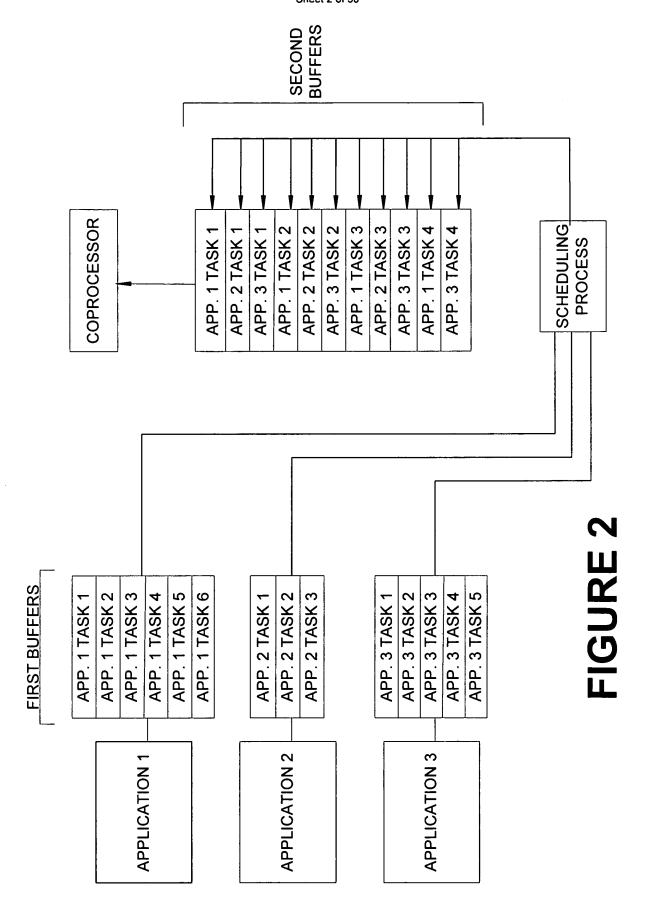


FIGURE 1 (prior art)

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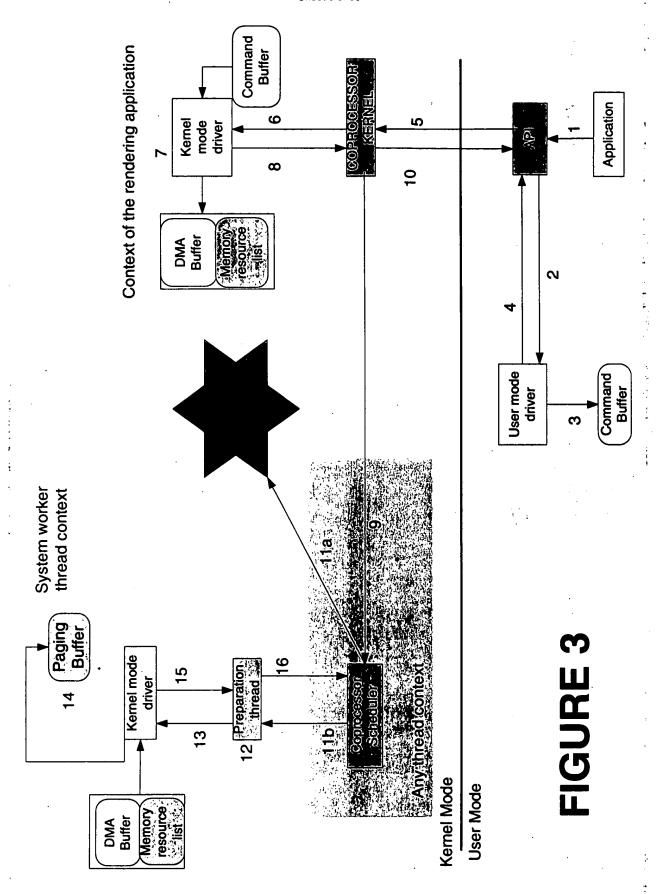
Inventors: Anuj B. Gosalia and Steve Pronovost

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Exemplary algorithm

PROCESS A: Submit (irgl passive, rendering thread context)

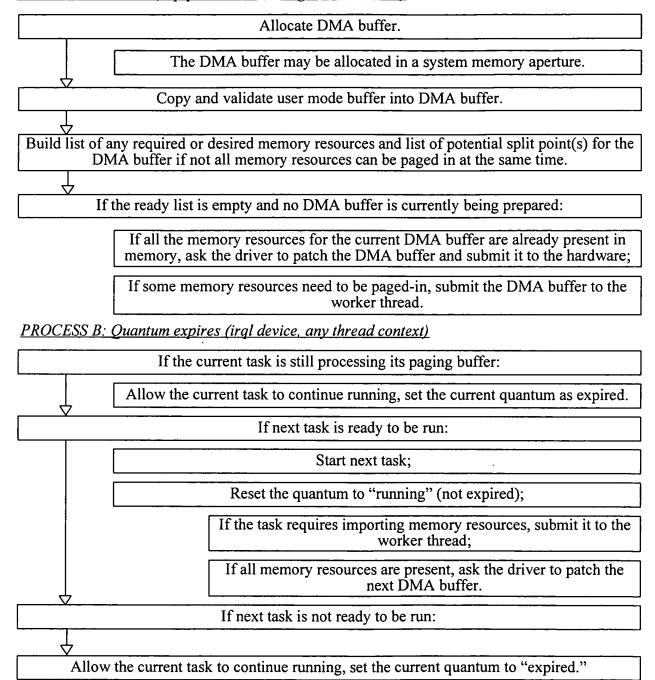


FIGURE 4(A)

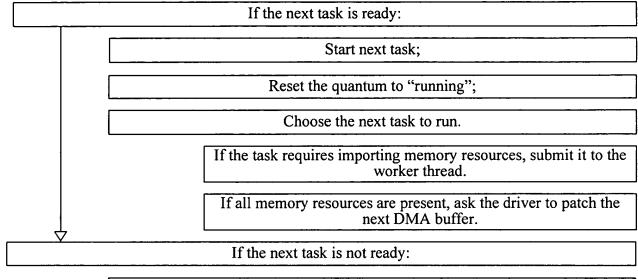
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Exemplary algorithm

PROCESS C: Task finishes (irgl device, any thread context)



Stall the coprocessor while the worker thread completes the next task setup or until an application submits a new buffer;

During worker thread completion, the priority of the worker thread is booted so the worker thread finishes its work as soon as possible.

FIGURE 4(B)

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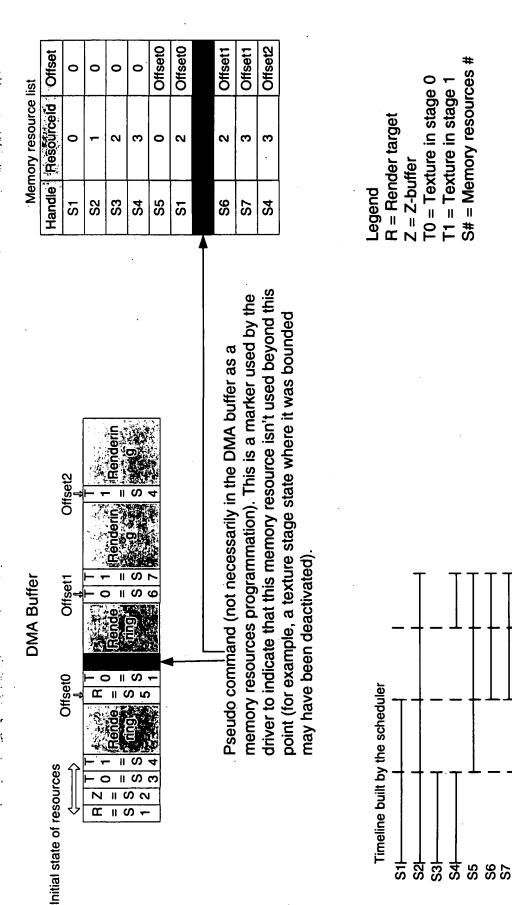
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FIGURE 5

Potential split points.



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Exemplary algorithm Provide a list of memory resources to a supplemental memory manager; The supplemental memory manager returns a list of memory resources that be moved, optionally specifying a move location. This list is called a "command list" for purposes of this description. If the video memory manager can't find a location for memory resources in the list, it can chose some allocated memory to evict; The supplemental memory manager can go through the list and inspect the segments; If the current process working set is below the commit limit in that segment. Mark some surfaces for eviction according to the current eviction policy; Increase the current eviction policy to be harsher next time around; Go back to the first step and try allocating suplemental memory again; If the current process is requiring more memory than the current commit limit; Split the DMA buffer based on the split point built from the timetable for memory resources; If the DMA buffer can't be split further but not all the

memory resources have been marked for eviction yet;

Mark everything for eviction;

Reduce the priority of the application causing the trashing so it doesn't cause as much trouble in the future;

Go back to the first step and try allocating supplemental memory again;

If the DMA buffer can't be split further and all memory resources have been marked for eviction already;

Reject the current DMA buffer for the application. Since this DMA buffer may have contained important state metrics, this process can be discontinued, and the application can be informed of the error.

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Command that requires pre-processing at runtime.

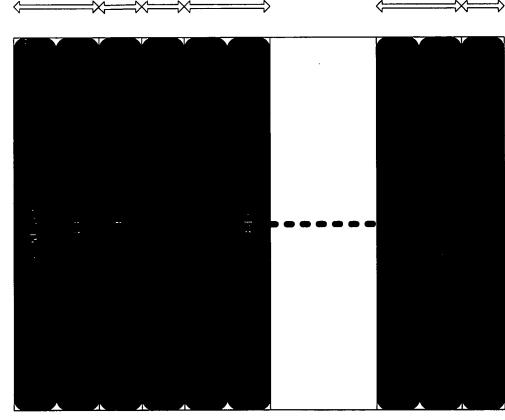
Command that doesn't require pre-processing at runtime.

Command that doesn't require pre-processing at runtime.

Command that requires pre-processing at runtime.

Command that requires pre-processing at runtime.

Last fence handling post-processing for commands in the BlitBuffer.



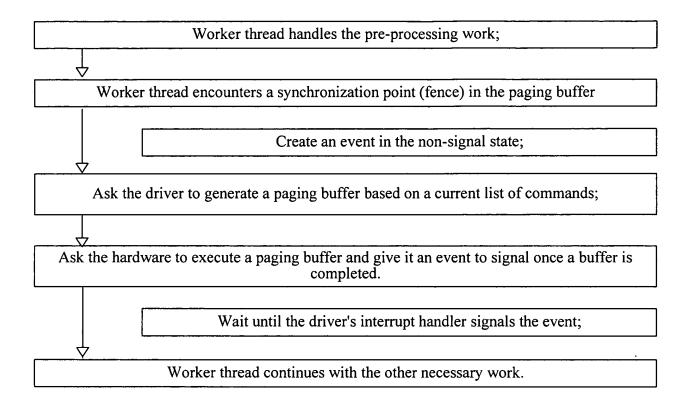
BlitBuffer

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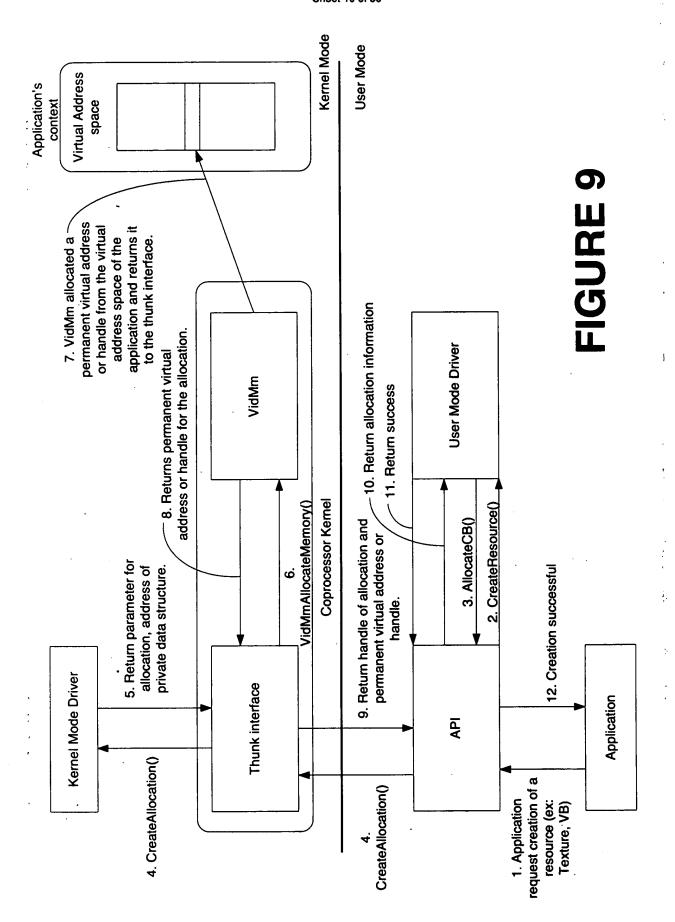
Exemplary algorithm



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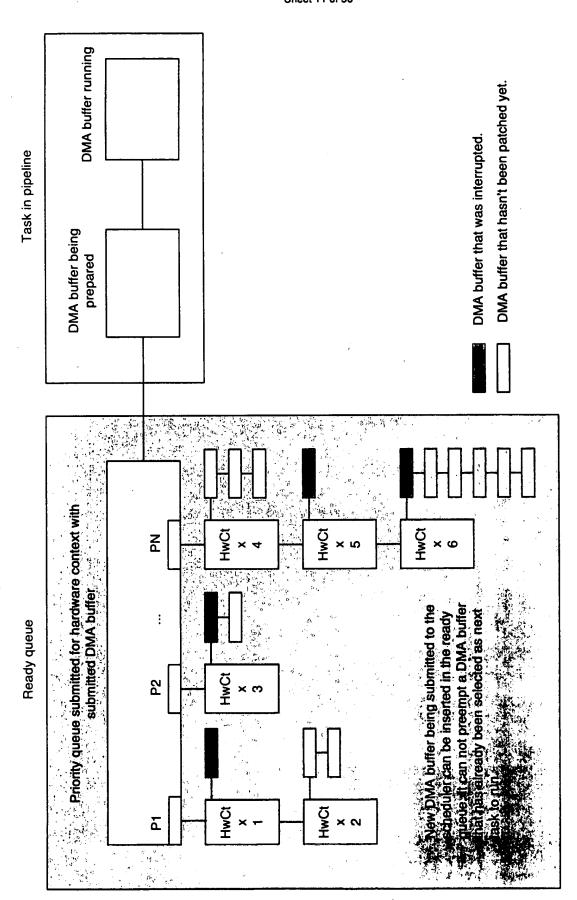
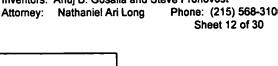


FIGURE 10

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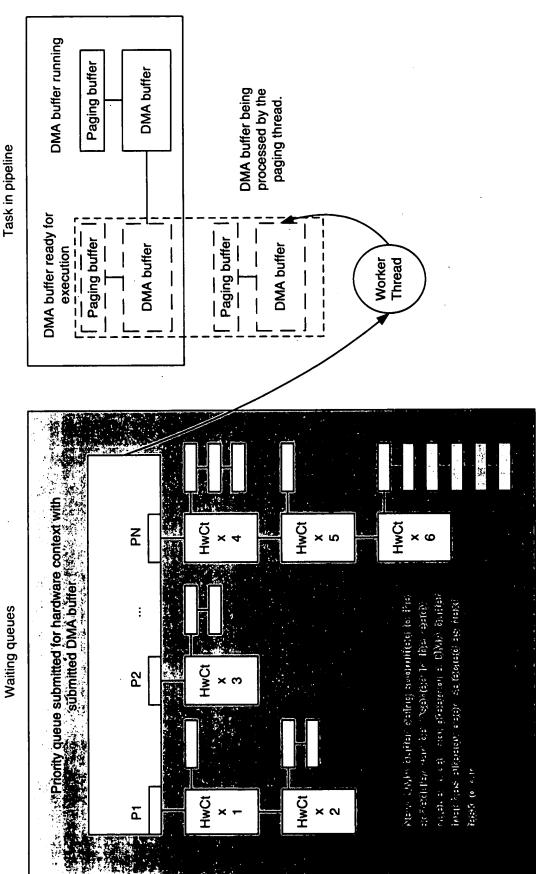


FIGURE .

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If all the memory resources for the current DMA buffer are already present in memory, If no DMA buffer is being prepared or is ready for execution.

PROCESS A: Submit (IROL passive, rendering thread context)

If the coprocessor is idle, give the DMA buffer to the coprocessor. Else insert the DMA buffer in the ready-to-execute slot.

If some memory resources need to be paged in, submit the DMA buffer to the paging thread.

Else, insert the DMA buffer at the end of the list for the current context

PROCESS B: Quantum expires (IRQL device, any thread context)

If the current task is still processing its paging buffer,

Allow the current task to continue running.

Set the current quantum as expired.

Else, if next DMA buffer is ready to be run,

Reset the current priority of the current context to its base priority.

Move the current context to the end of the queue for its priority.

Submit next DMA buffer to the coprocessor.

Reset the quantum as being running (not expired).

Choose the next DMA buffer to execute.

If the DMA buffer requires paging, submit it to the paging thread

Else, all memory resources are already present; just insert the DMA buffer in the ready slot.

Else, the next task isn't ready to be run;

Allow the current task to continue running.

Set the current quantum as expired.

PROCESS C: Task finishes (IROL device, any thread context)

If next DMA buffer is ready to be run,

Submit next DMA buffer to the coprocessor.

Reset the quantum as being running (not expired)

Choose the next DMA buffer to execute.

If the DMA buffer requires paging, submit it to the paging thread. Else, all memory resources are already present; just insert the DMA buffer in the ready slot.

Else, the next task isn't ready;

If the paging thread is currently working on the next DMA buffer, boost the priority of the worker thread temporarily so it finishes its work as soon as possible.

FIGURE 12(A)

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PROCESS D: Paging thread (IROL passive, system thread) Set current eviction policy to first policy.

Ask the memory manager to page in the resource list.

If all the resource were paged in successfully

Move the paging buffer and DMA buffer to the ready-to-execute slot.

If the quantum of the current DMA buffer is expired

Submit next DMA buffer to the coprocessor.

Reset the quantum as being running (not expired).

Choose the next DMA buffer to execute.

If the DMA buffer requires paging, submit it to the paging thread

Else, all memory resources are already present, just insert the DMA buffer in the ready slot;

Else if the memory manager failed because the paging buffer is full

Wait until the current DMA buffer's quantum end or finishes.

Submit the paging buffer to the coprocessor.

Wait until the paging buffer is done.

Go back asking the memory manager to paged-in the remaining of the resource list.

Else if the memory manager failed because there isn't enough available resource If we've passed the last eviction policy

Undo the resource move, or run the paging buffer.

Reject the DMA buffer.

We're done.

Else if the current eviction policy is above application interference.

If the DMA buffer hasn't been split yet.

Split the DMA buffer at the closest point to the current paged-in resources.

f no more resources are needed

Move the paging buffer and split DMA buffer to the ready-to-execute slot

Move the remaining DMA buffer back to the head of the ready queue for the context

If the quantum of the current DMA buffer is expired,

Submit next DMA buffer to the coprocessor.

Reset the quantum as being running (not expired). Choose the next DMA buffer to execute.

If the DMA buffer requires paging, submit it to the paging thread

Else, all memory resources are already present; just insert the DMA buffer in the ready slot;.

If VidMm returns an error saying no memory could be marked with the current policy, Ask VidMm to mark candidate for eviction using the current policy

increase the eviction policy.

Go back to the start of the eviction policy check.

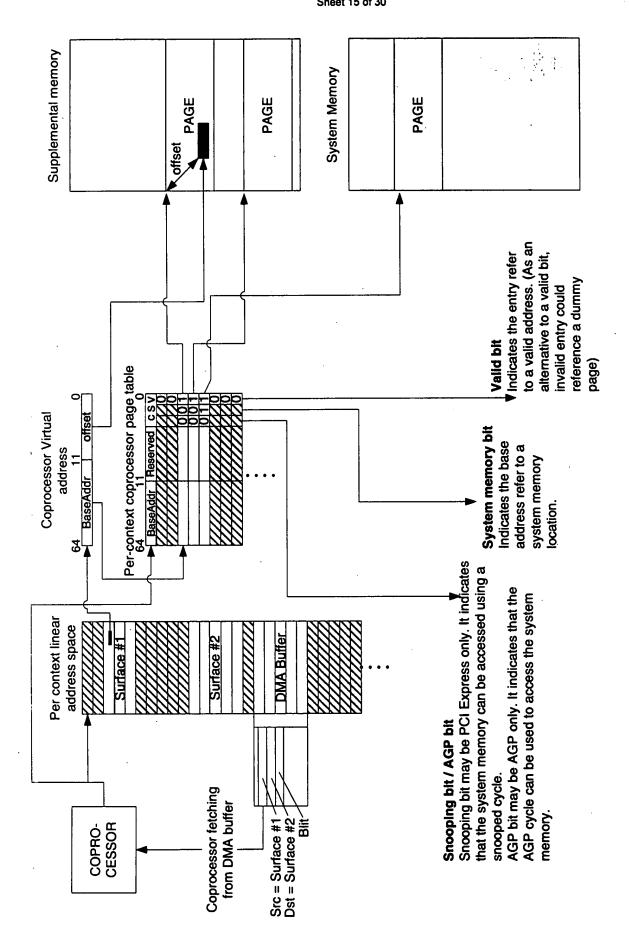
Else, some memory was marked.

Go back to trying to page in the resources.

FIGURE 12(B

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Sheet 16 of 30 Video memory System Memory PAGE PAGE PAGE offset Indicates the entry refer an alternative to a valid to a valid address. (As bit, invalid entry could reference a dummy Valid bit. page) Page Table Indicates the base System Memory bit. address refer to a system memory location. 3 Coprocessor Virtual that AGP cycle can be used to Per-context coprocessor Fable Addr Reserved May be AGP only. It indicates May be PCI Express only. It access the system memory. address page directory memory can be accessed ndicates that the system using a snooped cycle. AGP BIt. Snooping bit. 31 Per context linear address space **DMA Buffer** Surface #2 Surface **FIGURE 14** Indicates the entry refer to a valid page table. Coprocessor fetching Valid bit. from DMA buffer COPRO-CESSOR Src = Surfac #1 Dst = Surface #2 Blit

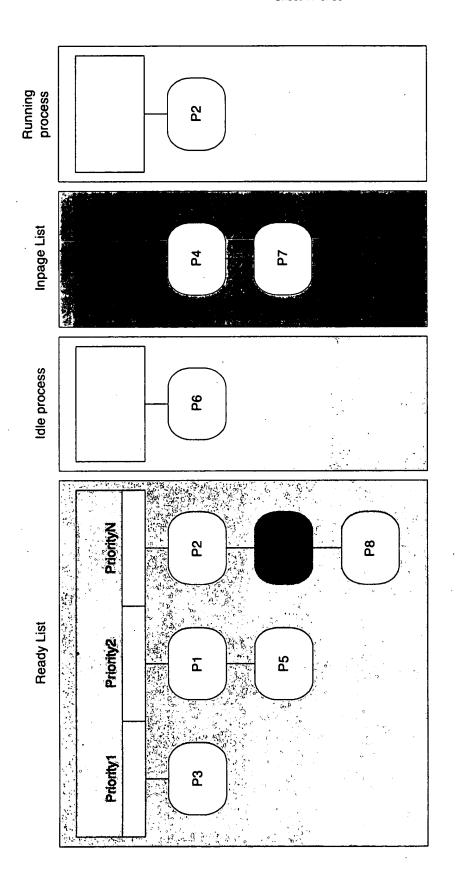
Title: SYSTEMS AND METHODS FOR ENHANCING PERFORMANCE OF A COPROCESSOR

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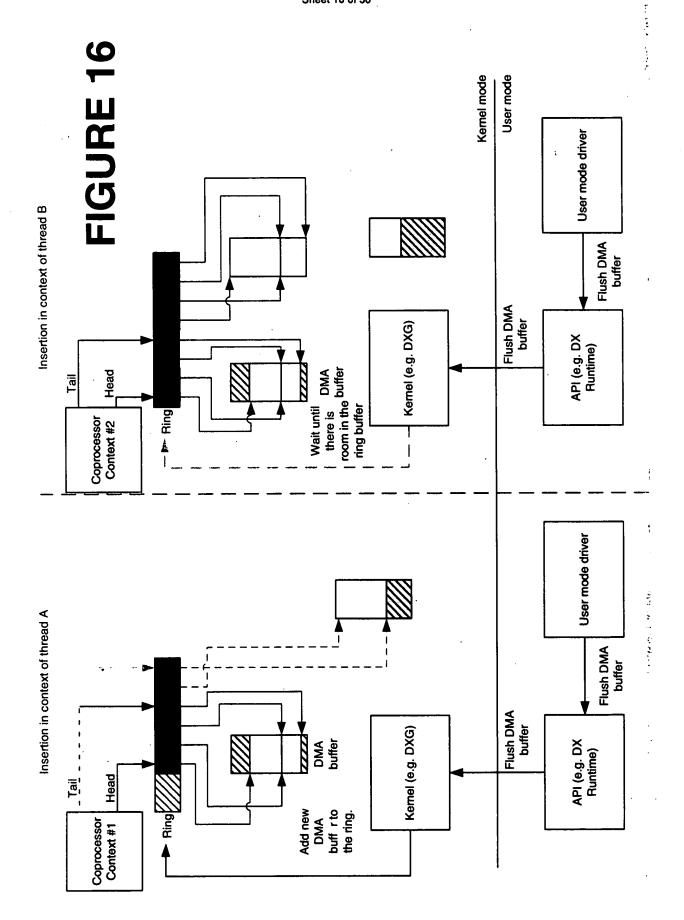
Inventors: Anuj B. Gosalia and Steve Pronovost Attorney: Nathaniel Ari Long Phone: (215) Phone: (215) 568-3100 Sheet 17 of 30



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Process the list of resources given, and update the usage information about allocations in this process. PROCESS A: Submit (IROL passive, rendering thread context, coprocessor Context mutex held) Acquire the VIDMM lock.

Take the scheduler lock.

Release the VIDMM lock.

Call the driver to insert the current DMA buffer into the ring.

If the driver succeeded

If the context was idle.

Insert the context back in the ready list at the tail of the queue for its current priority.

If there is no context transfer pending and the current context is lower priority than the current context.

Call the driver to context switch to this context.

Signal that a context switch is pending.

Release the scheduler lock.

If the driver failed, the ring was full.

Wait on an event that will be signaled when room becomes available.

After the wait, go back to acquiring the scheduler lock.

If there is enough room left in the DMA buffer for another submission.

Return to user mode with the current DMA buffer.

Acquire a new DMA buffer from the context's pool.

If DMA pool couldn't give another buffer at this time

Wait on an event that will be signaled when a DMA buffer is inserted back into the pool.

When the wait is over, go back to trying to get a new DMA buffer.

Return the new DMA buffer to user mode.

PROCESS B: Context switch done (IRQL device, any thread context)

Fake the scheduler lock.

If a higher priority context is now ready for execution.

Call the driver to context switch to the highest priority context.

Floo

Signal that no context switch is currently pending.

Release the scheduler lock

PROCESS C: Quantum expires (IRQL device, any thread context)

Take the scheduler lock.

Reset the current priority of the context to its base priority

Insert the context back at the end of the queue for its current priority.

If no context switches are currently pending.

Ask the driver to do a context switch to the highest priority context.

Release the scheduler lock.

FIGURE 17(A)

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PROCESS D: Task finishes (IROL device, any thread context) Take the scheduler lock

Ask the driver whether the context is really empty.

If the context is really empty.

Reset the current priority of the context to its base priority.

Insert the context in the idle list

If the context wasn't really empty.

If no context switches are currently pending.

Ask the driver to do a context switch to the highest priority context.

Release the scheduler lock.

PROCESS E: Page Fault (IRQL device, any thread context)

Take the scheduler lock.

Remove the context from the ready list.

Insert the context in the in page list as an atomic operation.

If in page thread currently sleeping.

Queue a DPC to signal to wakeup the worker thread.

Ask the driver to do a context switch to the highest priority context. If no context switch are currently pending.

Release the scheduler lock.

PROCESS F: Fault resolved (IROL device, any thread context)

Take the scheduler lock.

Remove the context from the in page list.

insert the context back in the ready list for its current priority.

If co context switches are currently pending, and the current context is higher priority than the currently running context.

Ask the driver to do a context switch to the highest priority context.

Release the scheduler lock.

FIGURE 17(B)

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PROCESS G: In page worker thread

Ask the driver for the list of resources required to make forward progress on the context. Go through the list of contexts in the inpage queue. Pick up the highest priority one. Take the VIDMM lock.

Find a location for each of the allocations required for forward progress.

Ask the driver to fill a DMA buffer with the memory transfer commands necessary to Invalidate the virtual address or handle for the allocation getting evicted

bring the required allocations to their selected spots.

Release the VIDMM lock.

Submit the VidMm context as a regular coprocessor context.

If the list of contexts is empty, sleep until an item gets added

Go back to the beginning of the loop.

PROCESS H: Periodic timer (passive level, system thread context)

Take the scheduler lock.

Increase the current priority of each context.

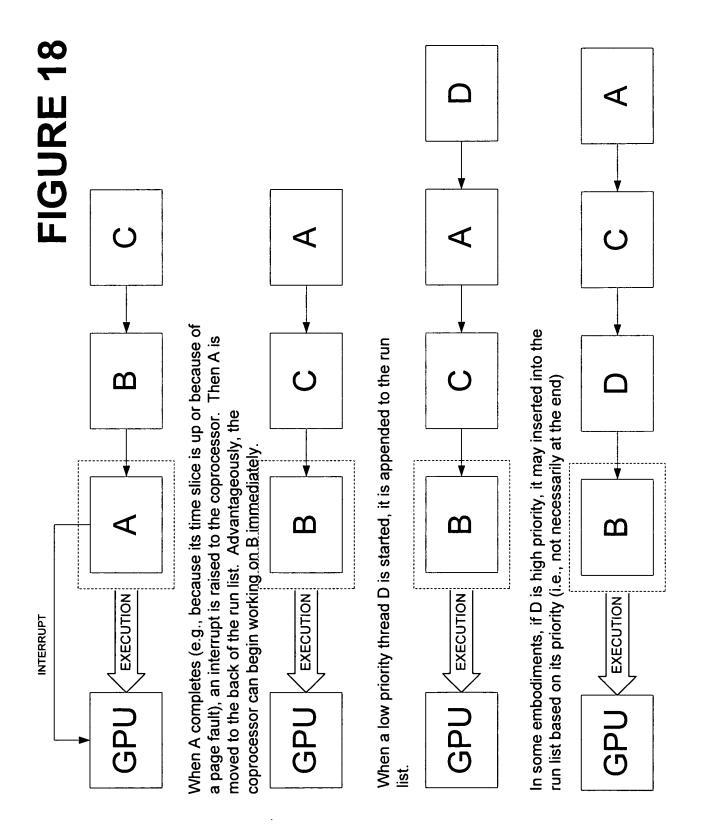
Release the scheduler lock.

FIGURE 17(C)

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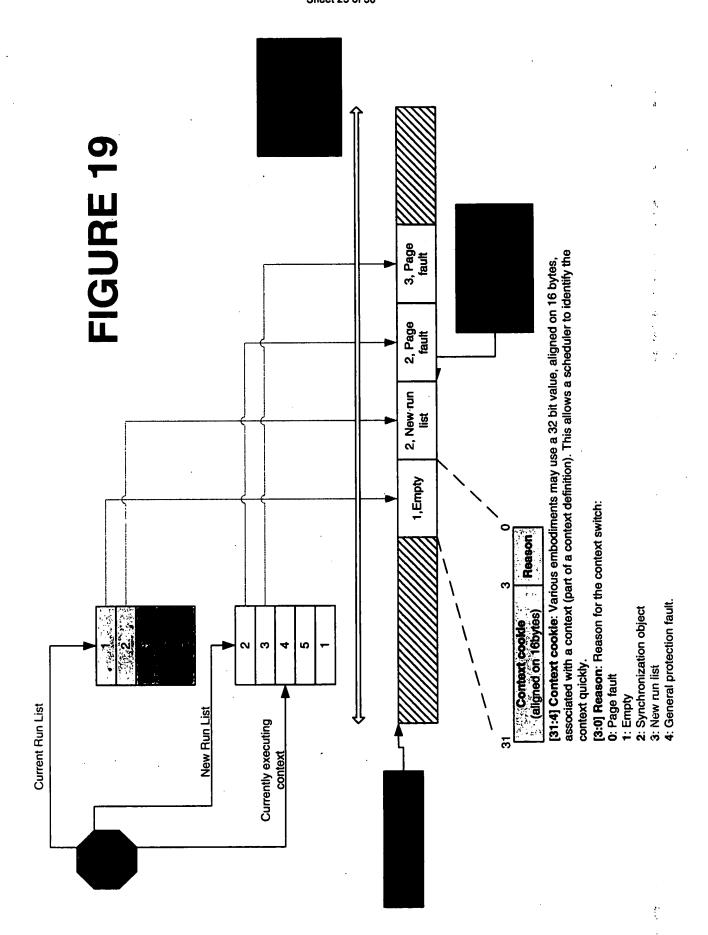
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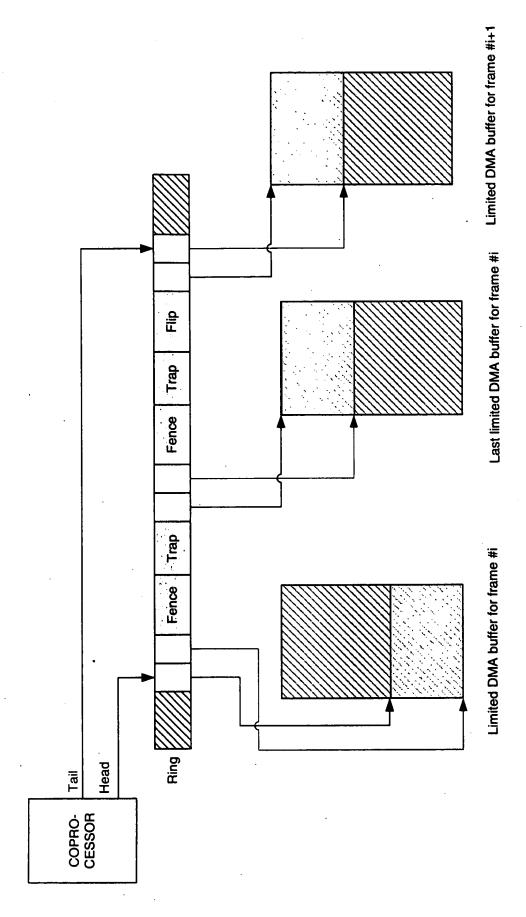
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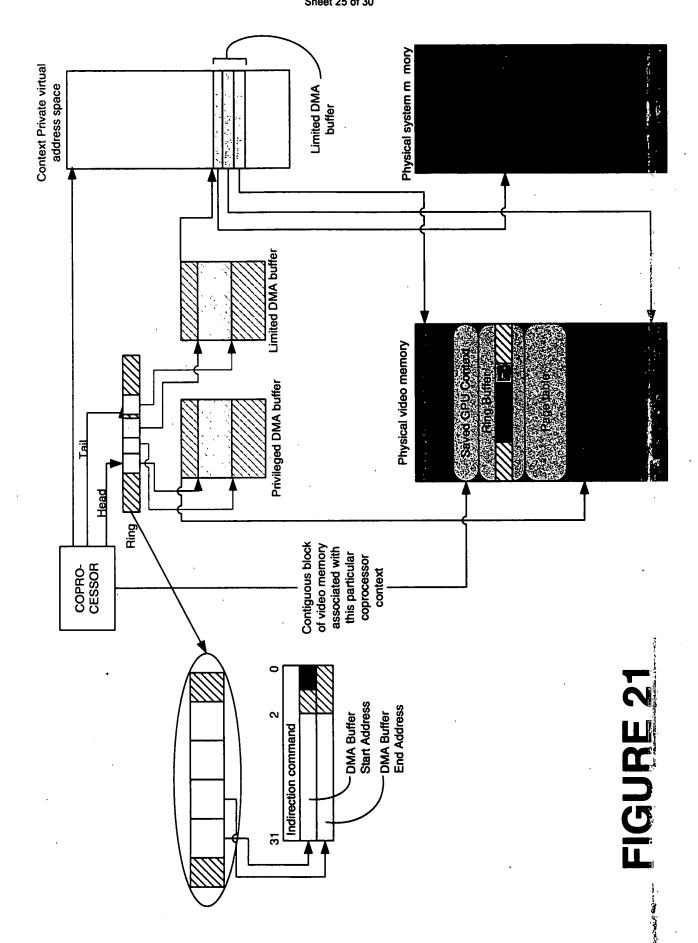


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notify the scheduler that flip #2

is done. At this point, the

current base address is

6. Driver sample current base address for the display and

3. Driver sample current

base address for the

2. Base - address for

latches new base addres for flip #3.

5. Coprocessor

4. Base address for

flip #2 becomes

effective.

atches new base addres for flip #1.

1. Coprocessor

က

Variable length Interrupt

latency

different than the latched base

done. At this point in time the current base address

display and notify the scheduler that flip #1 is

flip #1 becomes

effective.

address. The coprocessor

may not acknowledge that flip

#3 is done.

latched base address.

is the same as the

VSYNC Pulse (coprocessor copies

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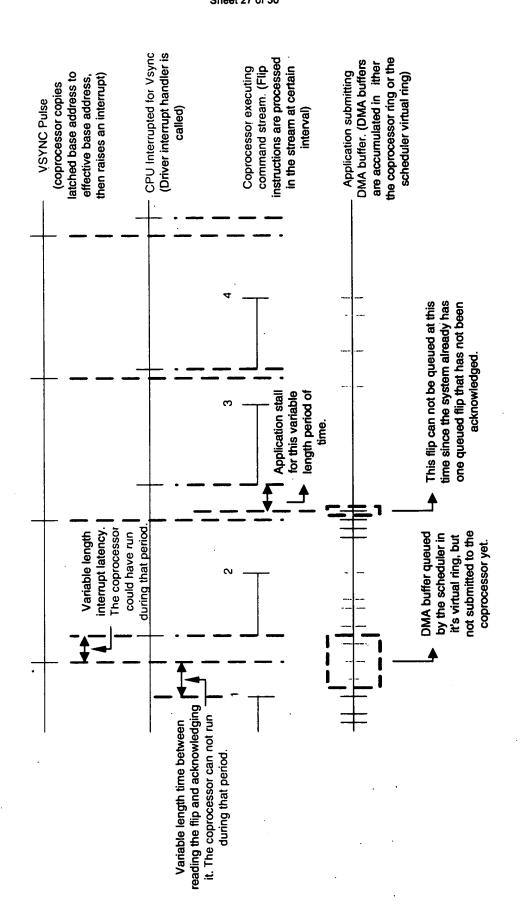


FIGURE 23

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Coprocessor Thread A

Pseudo code:

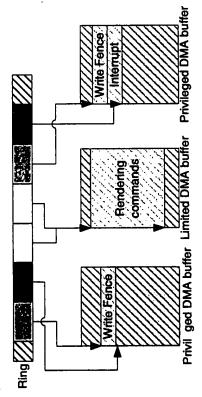
// Wait until we have exclusive access to the shared surface.

//
DxAcquireMutex(gSharedMutex);

// Set the shared surface as the render target. // DxSetRenderTarget(gSharedSurface); // Render what we need in the shared surface.//
DxDrawSomething();// We're done with rendering, release the mutex.

Coprocessor stream:

DxReleaseMutex(gSharedMutex)



Coprocessor Thread B

Pseudo code:

// Wait until we have exclusive access to the shared surface.
//
DxAcquireMutex(gSharedMutex);
// Set the shared surface as a texture.
//
DxSetTexture(gSharedSurface):
// Render what we need with the shared surface.
//
DxDrawSomething():
// We're done with rendering, release the mutex.
//
DxReleaseMutex(gSharedMutex)

Coprocessor stream:

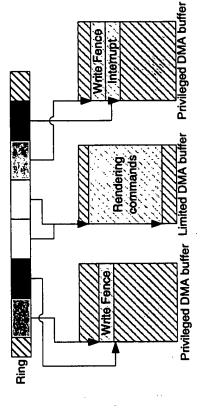


FIGURE 24

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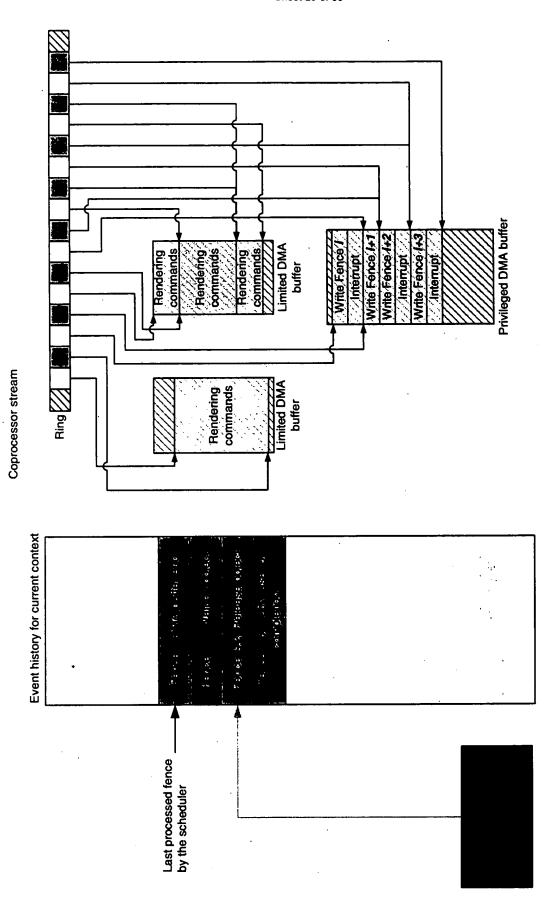


FIGURE 25

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